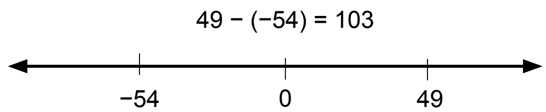
7:12 Temperature Change

Teacher Notes

Central math concepts

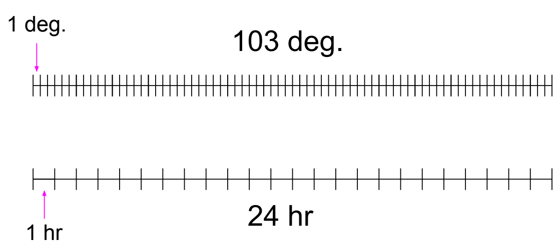
A number line diagram is helpful for representing the initial and final temperatures and for visualizing and calculating the magnitude of the temperature increase.



With reference to this number line diagram (not drawn to scale), the initial temperature is at the point marked -54. The first 54 degrees of temperature increase will bring the temperature to zero, then another 49 degrees of temperature increase will bring the temperature to the final temperature of 49 degrees. The total increase is therefore the sum of the two increases, or 54 + 49 = 103 degrees. A procedural version of this calculation could proceed as, "temperature change = final temperature - initial temperature," with the subtraction performed as 49 - (-54) = 49 + 54 = 103.

In the rational number system, subtraction is reducible to addition; this is why there are no properties of operations that refer to subtraction. Specifically, subtraction in the rational number system means "adding the additive inverse," that is, $A - B$ means $A + (-B)$. In particular then, 49 - (-54) = 49 + -(-54), where -(-54) refers to the additive inverse of -54. By definition, the additive inverse of -54 is the number that makes 0 when added to -54, and that number is 54. So -(-54) = 54 and the original subtraction calculation 49 - (-54) becomes 49 + -(-54) = 49 + 54 = 103.

Left out of the above account so far is any sense of how fast the temperature increase happened, or how steady the increase was. Thinking about the average rate of change of a quantity



means imagining that the change happened at a constant rate, even if we know that in reality it didn't happen that way. The diagram (not drawn to scale) gives a sense of how the change in temperature of 103 degrees compares to the duration of time over which the change took place, 24 hr. In the diagram, 103 degree units compose the same length as 24 hour units. Because 103 is approximately 4.29 times as much as 24, each degree unit must be smaller than each hour unit by that same factor. In other words, there are about 4.29 degree units for every hour unit. That implies a unit rate of 4.29 degrees per hour for the process, imagining it as a constant-rate process.

Even though the temperature was unlikely to have changed at a constant rate, the average rate provides useful insight of the intensity of the event. The two numbers 103 degrees and 24 hours aren't as informative by themselves as they are when combined with the new fact, produced through division, that in every hour on average, the temperature climbed

> 7:12 In 1972 in Loma, Montana, the temperature changed from −54°F to +49°F in a 24-hr period. Calculate the average rate at which the temperature changed. Answer to the nearest tenth in units of degrees/hr.

Answer

4.3 degrees/hr.

Click here for a student-facing version of the task.

Refer to the Standards

7.RP.A.1, 7.NS.A; MP.2, MP.4. Standards codes refer to www.corestandards.org. One purpose of the codes is that they may allow a task to shed light on the Standards cited for that task. Conversely, reading the cited Standards may suggest opportunities to extend a task or draw out its implications. Finally, Standards codes may also assist with locating relevant sections in curriculum materials, including materials aligned to comparable standards.

Aspect(s) of rigor:

Concepts, Application

Additional notes on the design of the task

- The event described in task 7:12 occurred on January 14th–15th, 1972. See Horvitz et al. (2002), "A National Temperature Record at Loma, Montana."

Curriculum connection

1. In which unit of your curriculum would you expect to find tasks like 7:12? Locate 2-3 similar tasks in that unit. How are the tasks similar to each other, and to 7:12? In what specific ways do they differ from 7:12?

more than 4 degrees. Perhaps, had we been outside during this event, such a rapid warming trend would have been directly perceptible.

Relevant prior knowledge

The following mathematics knowledge may be activated, extended, and deepened while students work on the task: representing rational numbers on a number line; subtracting signed rational numbers; and understanding unit rates and average rates and relating them to ratios of dimensioned quantities.

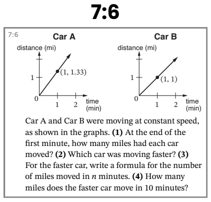
Extending the task

How might students drive the conversation further?

- Students could calculate average rates of temperature change for other extreme weather events, such as the "heat burst" that occurred in Hobart, Oklahoma on May 23, 2005, when temperatures rose from 74.1°F to 93.4°F in a 5-minute period (Christopher C. Burt, "Extreme Short-Duration Temperature Changes in the U.S.").
- Students could plot the given information in the coordinate plane as the pair of points (0, -54) and (24, 49). The average rate of change of temperature corresponds to the steepness of the line joining these two points.

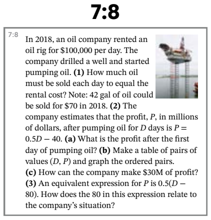
Related Math Milestones tasks

7:6

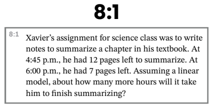

7:6

Car A and Car B were moving at constant speed, as shown in the graphs. **(1)** At the end of the first minute, how many miles had each car moved? **(2)** Which car was moving faster? **(3)** For the faster car, write a formula for the number of miles moved in *n* minutes. **(4)** How many miles does the faster car move in 10 minutes?

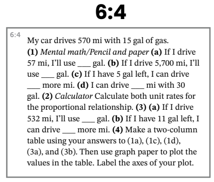
7:8


7:8 In 2018, an oil company rented an oil rig for $100,000 per day. The company drilled a well and started pumping oil. **(1)** How much oil must be sold each day to equal the rental cost? Note: 42 gal of oil could be sold for $70 in 2018. **(2)** The company estimates that the profit, P, in millions of dollars, after pumping oil for D days is $P = 0.5D - 40$. **(a)** What is the profit after the first day of pumping oil? **(b)** Make a table of pairs of values (D, P) and graph the ordered pairs. **(c)** How can the company make $30M of profit? **(3)** An equivalent expression for P is $0.5(D - 80)$. How does the 80 in this expression relate to the company's situation?

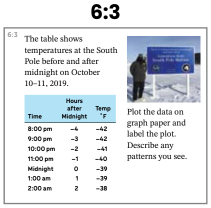
8:1


8:1 Xavier's assignment for science class was to write notes to summarize a chapter in his textbook. At 4:45 p.m., he had 12 pages left to summarize. At 6:00 p.m., he had 7 pages left. Assuming a linear model, about how many more hours will it take him to finish summarizing?

6:4


6:4 My car drives 570 mi with 15 gal of gas. **(1)** *Mental math/Pencil and paper* **(a)** If I drive 57 mi, I'll use ___ gal. **(b)** If I drive 5,700 mi, I'll use ___ gal. **(c)** If I have 5 gal left, I can drive ___ more mi. **(d)** I can drive ___ mi with 30 gal. **(2)** *Calculator* Calculate both unit rates for the proportional relationship. **(3)** **(a)** If I drive 532 mi, I'll use ___ gal. **(b)** If I have 11 gal left, I can drive ___ more mi. **(4)** Make a two-column table using your answers to (1a), (1c), (1d), (3a), and (3b). Then use graph paper to plot the values in the table. Label the axes of your plot.

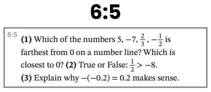
6:3


6:3 The table shows temperatures at the South Pole before and after midnight on October 10–11, 2019.

Time	Hours after Midnight	Temp °F
8:00 pm	−4	−42
9:00 pm	−3	−42
10:00 pm	−2	−41
11:00 pm	−1	−40
Midnight	0	−39
1:00 am	1	−39
2:00 am	2	−38

Plot the data on graph paper and label the plot. Describe any patterns you see.

6:5


6:5 **(1)** Which of the numbers $5, -7, \frac{2}{3}, -\frac{1}{2}$ is farthest from 0 on a number line? Which is closest to 0? **(2)** True or False: $\frac{1}{2} > -8$. **(3)** Explain why $-(-0.2) = 0.2$ makes sense.

Tasks **7:6 Car A and Car B** and **7:8 Oil Business** involve unit rates.

In later grades, **8:1 Xavier's Notes** involves applying the mathematics of rates as a modeling approach in a situation where, as in task 7:12, the actual rate is unlikely to be constant.

In earlier grades, task **6:4 Gas Mileage** involves unit rate calculations. Task **6:3 South Pole Temperatures** features negative temperature values, and task **6:5 Positive and Negative Numbers** concentrates on pre-arithmetic properties of signed rational numbers.

Curriculum connection (continued)

2. Thinking about the curriculum unit you identified, at what point in the unit might a task like 7:12 help students converge toward grade-level thinking about the important mathematics in the task? What factors would you consider in choosing when to use such a task in the unit?*

* Math Milestones™ tasks are not designed for summative assessment. Used formatively, the tasks can reveal and promote student thinking.

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Teacher Notes

Anticipating and responding to student thinking about the task

Imagine how students might think about the task, and what you might see and hear while they work.

On this page, you can write your thoughts on the following questions.

Solution Paths

- What solution paths might you expect to see?
- What representations might you see? What correspondences between those representations might be noticed by students (or be worth pointing out to students) and discussed by them?
- What misconceptions or partial understandings might be revealed as students work on the task? How could you respond to these positively and productively?

Language

- What might you expect to hear from students engaged with the task? What does that language reveal about their mathematical thinking, and how might you respond to different ways of thinking?
- If students are using early English or using multiple languages in an integrated communication system, how might you help their classmates see those mathematical ideas as valuable?
- Even when using nascent language, students are thinking and communicating their thinking. What might it look like to respond positively and productively to the mathematics in their thinking before giving feedback on the language used?

Identity, Agency, and Belonging

- How can you engage students' interests, experiences, or funds of knowledge?
- How can you build students' self-confidence as learners, thinkers, and doers of mathematics?
- What choices are there for a student to make in the task? How can you build students' agency to the point where they notice and make these choices to solve problems?
- How might one use feedback to build student agency? Where might there be opportunities to build students' self-confidence?